Exploiting boom times. Southern Boobook Owl *Ninox novaeseelandiae* diet during a rodent irruption in central Australia

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ABSTRACT

Populations of Australian desert rodents are known to undergo booms in response to resource pulses following periods of high rainfall. Australia's arid-adapted Tyto owls have been recorded responding functionally and numerically to these small mammal booms, though it is not known whether the Southern Boobook Ninox novaeseelandiae is able to respond similarly. We aimed to determine whether Southern Boobooks could find and exploit a localised rodent irruption in the western Simpson Desert, in a location with few roost trees and no tree hollows. Boobook owls immigrated to the site from an estimated distance of ≥ 32 km and appeared to be resident over a period of ≥ 4 months, coinciding with a localised irruption of Plains mice Pseudomys australis. Dietary analysis confirmed that the owls specialised on small mammals, with rodent and dasyurid species accounting for c. 98% of prey items and > 99% of prey biomass. There was no evidence of reproductive activity among the owls and they vacated the area as the small mammal irruption subsided. Although a dietary generalist across its range, our results indicate the Southern Boobook is capable of specialising on small mammals during population irruptions.

Key words: Desert, Owl, Rodent, Small mammal, Irruption

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Introduction

Populations of Australian desert rodents are known to undergo dramatic increases in population size (referred to as "booms") in response to resource pulses following periods of high rainfall (Letnic and Dickman 2006; Greenville *et al.* 2012). A range of predatory vertebrates have been recorded responding to these peaks in prey availability (Sinclair *et al.* 1990). Among these, nocturnal predatory birds including the Pacific barn owl *Tyto javanica*, eastern grass owl *Tyto longimembris* and letter-winged kite *Elanus scriptus* have been recorded immigrating to areas where they were formerly absent and/or breeding intensively in response to the abundant food (Olsen and Doren 2002; Pavey *et al.* 2008a, b). During rodent irruptions, the diet of these species typically includes large numbers of the most abundant small mammals available (Debus *et al.* 2004; Pavey *et al.* 2008b).

The only other nocturnal raptor occurring in most of arid Australia is the Southern Boobook *Ninox novaeseelandiae*. In contrast to the barn owl, the Southern Boobook is considered resident in much of mainland Australia and it is currently not known whether it responds to rodent irruptions. The species is considered an invertebrate specialist (Olsen 1999; Penck and Queale 2002), although some studies have shown that small mammals may comprise a substantial component of the diet of this relatively small hawk owl (maximum body mass 370 g, Higgins 1999). For example, in a Victorian field study and review of previous dietary work, McNabb (2002) found that the species can prey heavily on vertebrates where they are abundant.

In contrast to the larger forest owls of Australia, the spatial ecology of Boobook owls has received little research attention. All previous studies have been undertaken in cool-temperate regions of south eastern Australia where Boobook owls have relatively fixed home ranges and individuals may have non-overlapping breeding versus non-breeding ranges (Olsen and Taylor 2001; Olsen et al. 2011). The spatial ecology of Boobook owls in arid Australia has not been studied and it is unknown whether they are able to exploit irruptions of small mammals that occur outside of their breeding habitat.

Here we report on observations of the behaviour and diet of the Southern Boobook on the western edge of the Simpson Desert in the Northern Territory.

Methods

The study area is located on Andado Station on the western edge of the Simpson Desert, approximately 220 km southeast of Alice Springs in the Northern Territory (-25.1272°, 135.3962°). The region typically experiences hot summers (maximum often >40° C) and cool winters (minimum often

<5° C), with highly variable rainfall averaging c.150 mm per annum (Bureau of Meteorology 2013).

The localised irruption of rodents (predominately Plains mice *Pseudomys australis*) occurred in 2009 on a cracking clay plain situated on the western edge of a more extensive, though isolated, stony gibber plain (see Pavey and Nano 2013). Parallel sand ridges and flats, typical of the Simpson Desert, dominate the surrounding landscape. In the immediate vicinity of the clay plain, the only vegetation judged suitable for Boobook owl roosting was three small stands of coolibahs (*Eucalyptus coolabah*) (n = 7-9) on the western and eastern edges of the plain. These coolibahs were a maximum height of seven metres above ground and typically featured dense shady canopies, though none had hollows of sufficient size to allow Southern Boobook entry. The nearest ideal nesting habitat for Boobook owls (i.e. tree hollows) is an extensive coolibah swamp 32 km to the south.

We surveyed for the presence of Boobook owls (and other nocturnal predators) on four occasions spanning the period from the initial rodent irruption to the decline of the irruption (March, June and September 2009, February 2010). On each survey we searched all coolibahs on the edge of the plain during the day for roosting birds and collected any regurgitated pellets found beneath roosts. We also carried out a 10 km drive spotlight transect which traversed the cracking clay plain and passed within 50 m of two of the coolibah groves. Spotlight surveys commenced approximately 1 to 2 h after sunset and involved a single observer with a 100 W handheld spotlight who sat on the roof of a four-wheel-drive vehicle moving at 15-20 km/hour to detect animals.

Collected owl pellets were soaked in warm soapy water and placed through a 4 mm sieve to separate out large bones and the remaining material was put through a 1 mm sieve to separate out the smaller bones. Skulls, jaw bones, dentaries and any other identifiable material were used in identification. Identification of dasyurid marsupials (*Dasyuridae*) was based primarily on tooth structure. We identified material by comparison with skull and jaw material held in a reference collection of central Australian mammals, together with reference to a key for *Sminthopsis* spp. (Archer 1981). We determined the number of individuals of each prey species taken by counting the number of skulls and left and right jaw bones present and using whichever count was the higher.

Results

The first Southern Boobook was recorded in June 2009 when a single adult was observed on the ground on the cracking clay plain during spotlight sampling. Daytime searches during this survey also revealed one adult Boobook roosting in a coolibah (possibly the same individual) and 30 regurgitated pellets were collected from underneath three coolibahs. In the following survey in September 2009, no Southern Boobooks were observed on the spotlight transect. However, two adult birds were located roosting in the coolibahs and a dismembered adult Boobook was also located on the ground near a coolibah. Twenty-five pellets were collected from underneath four coolibahs at this time. At no stage during the June and September surveys were Boobooks observed nesting or roosting in corvid or raptor nests (the only potential nest sites available). Southern Boobooks appeared to have vacated the area by February 2010, with no individuals observed active at night or roosting by day and no fresh (intact) pellets located underneath the coolibahs. No additional nocturnal predatory bird species were located during the surveys.

Dietary analysis of the collected pellets showed that Boobook owls fed predominantly on small mammals, which were present in all owl pellets collected and accounted for > 99.5% of the biomass of recorded prey items (Table 1). Although a relatively high proportion of small mammals could not be identified to species level from skull and dental remains (due to the extreme mastication typical of Ninox owls), we were able to identify five species (Table 1). The dominant of these was the nationally vulnerable (EPBC Act) Plains Mouse, which was present in at least 60% of the pellets and accounted for a minimum of 65.7% of the biomass of prey items located (Table 1). It is also likely that a substantial proportion of the unidentified mammal and rodent remains were *P. australis*.

Discussion

Our study shows that the Southern Boobook can exploit localised rodent irruptions in areas outside of breeding habitat in arid Australia. Boobooks immigrated to an area in response to the highly localised abundance of small mammals, dominated by a single species of rodent (Figure 3a in Pavey and Nano 2013). While in the area, Boobook owls fed almost exclusively on small mammals and apparently vacated the area as their breeding season approached and as the population of the dominant rodent declined. This response is similar to that exhibited by the eastern barn owl (Pavey et al. 2008b), a well-known irruptive avian predator in arid regions. However, the barn owl relies on a greater abundance of small mammals to trigger irruptions in to the study area (Pavey and Nano, 2013).

Through extensive fieldwork in the region during the period 2005-2012, it is apparent that Southern Boobooks are uncommon in this part of the Simpson Desert. The nearest location we have recorded the species is in the floodout of the Finke River, approximately 85 km to the south west. Other potentially suitable breeding habitat, with large hollow-bearing coolibahs and/or river red gums, occurs at Andado Swamp 32 km to the south and the Hale River floodout 75 km to the north east. Hollow-bearing trees are an important requirement for the species as it is similar to all *Ninox* species in being an obligate hollow nester (Higgins 1999).

Seasonal migrations have previously been recorded for Southern Boobooks in a cool-temperate region of Australia, with owls exhibiting separate breeding and non-breeding ranges (Olsen and Taylor 2001; Olsen *et al.* 2011). Therefore, it is possible that owls in our study area have the capability to exploit spatially patchy resources across a larger proportion of the landscape outside of their breeding season and then contract to core breeding habitat when required. Because Boobooks breed during

Table 1 – Relative importance of prey groups and species in Southern Boobook owl diet (55 pellets) in the Simpson Desert, Australia, during a rodent irruption in 2009

Prey species	Body mass (g)[a]	Minimum number of individuals	Frequency (%)	Biomass g (%)[b]
Insect				
Beetle	1	1	1 (1.8)	1 (<0.1)
Mammal				
Unidentified	29	6	6 (10.9)	174 (4.7)[c]
Dasyurid				
Unidentified	15	7	6 (10.9)	105 (2.8)[d]
Sminthopsis sp.	15	3	3 (5.4)	45 (1.2)[d]
S. crassicaudata	15	4	4 (7.3)	60 (1.6)
Rodent				
Unidentified	33	19	13 (23.6)	627 (16.9)[e]
Pseudomys australis	58	42	33 (60.0)	2436 (65.7)[f]
Notomys alexis	36	2	2 (3.6)	72 (1.9)
Leggadina forresti	20	7	7 (12.7)	140 (3.7)
Mus musculus	18	2	2 (3.6)	36 (0.1)
Reptile				
Gecko	10	1	1 (1.8)	10 (0.3)
Total		88		3706

[a] Mean body mass data from Menkhorst and Knight (2001), [b]Biomass calculated from body mass x minimum number of individuals, [c]Calculated from mean of all recorded mammal species body masses combined, [d]Calculated based on the mean of the only dasyurid species recorded, [e]Calculated from the mean of all recorded rodent species body masses combined, [f]*P. australis* remains included jaws from juveniles to adults and thus the biomass totals may be overestimated for this species.

the warmer spring-summer months (Olsen 1999), this potential contraction to breeding habitat would coincide with increased diversity and abundance of invertebrate prey (Palmer 2010).

Although Southern Boobooks have previously been shown to prey heavily on vertebrates (McNabb 2002), the degree of specialisation observed in our study is the strongest recorded yet. While dietary data for the species are lacking from elsewhere in arid Australia, the ability to exploit periodically abundant food sources may be an important adaptation to Australia's arid zone. The main prey of the Southern Boobook in our study area, the Plains Mouse, has a maximum adult body mass of about 70 g (Pavey *et al.* 2008a). This prey size is significantly lower than the maximum record of 420 g (McNabb 2002) indicating that it is well within the normal prey size range. Remains included bone and jaw fragment from juvenile and adult Plains Mouse individuals.

The Southern Boobook is the most arid-adapted *Ninox* owl. The high degree of plasticity in food exhibited by the Southern Boobook may be an important factor in its wide distribution and broad habitat tolerances. This is in contrast to the larger forest and woodland-dwelling *Ninox* and *Tyto* species that rely heavily on small-to-medium sized mammals (Estbergs and Brathwaite, 1984; Kavanagh, 2002). The broad diet of the Southern Boobook differs from the similar sized *T. javanica* which is a small mammal specialist in arid Australia and across its range (Morton 1975; Heywood and Pavey 2002; Pavey *et al.* 2008b). However, both species specialise on small mammals during population outbreaks in arid Australia.

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